CLAIMS

1. A levelling machine comprising upper and lower work rolls for engaging a workpiece; upper and lower backup rollers supporting the work rolls against the workpiece; upper and lower backup carriers to which the upper and lower backup rollers are rotationally mounted respectively; a first pivot axis about which the lower backup carriers may pivot; a second pivot axis about which the upper backup carriers may pivot; wherein the first and second axes are substantially parallel and in use are fixed in position one relative to the other.

2. A levelling machine according to Claim 1 wherein upper and lower work rolls each or individually comprise a series of rollers mounted on bearings where the axes of rotation of the bearings lie on a common plane.

3. A levelling machine according to any preceding claim wherein at least one intermediate roll is located between the upper work rolls and the upper backup rollers.

4. A levelling machine according to any preceding claim wherein the first pivot axis is coincident with axis of rotation of last roller of lower work rolls.

5. A levelling machine according to any preceding claim wherein the second pivot axis is coincident with axis of rotation of first roller of upper work rolls.

6. A levelling machine according to any preceding claim wherein there are N upper work rolls and N+1 lower work rolls; where N is an integer.

7. A levelling machine according to any of Claims 1 to 5 wherein there are N upper work rolls and N - 1 or N lower work rolls; where N is an integer.

8. A levelling machine according to Claim 6 or 7 where integer N is between 5 and 11 and preferably 8.

9. A levelling machine according to any preceding claim wherein there are M lower backup carriers and M+1 upper backup carriers; where M is an integer.

10. A levelling machine according to any of Claims 1 to 8 wherein there are M lower backup carriers and M - 1 upper backup carriers; where M is an integer.

11. A levelling machine according to Claim 9 or 10 where integer M is between 4 and 12 and preferably 7

12. A levelling machine according to any preceding claim wherein the diameter of the work rolls is D, the rolls are displaced at equal centres C wherein second pivot axis is also a vertical distance D above first pivot axis and a horizontal distance C(0.5N-1) from first pivot axis; where N is the total numberof work rolls.

13. A method of levelling material using a levelling machine according to any preceding claim comprising the steps of:

measuring the reaction load at load points on the lower backup carriers;

adjusting upward forces applied proximal the free end of each lower backup roller carrier so that calculated reaction loads are induced at load points located on the pivot axis of each lower backup roller carrier;

wherein said calculated reaction loads are calculated by an algorithm based upon there being a uniformly distributed stress in the material being processed as it exits the work rolls.

14. A method of levelling material using a levelling machine according to any of Claims 1 to 12 comprising the steps of:

measuring the reaction load at load points on the upper backup carriers;

adjusting downward forces applied proximal the free end of each upper backup roller carrier so that calculated reaction loads are induced at load points located on the pivot axis of each of each upper backup roller carrier;

wherein said calculated reaction loads are calculated by an algorithm based upon there being a uniformly distributed stress in the material being processed as it exits the work rolls.

15. A method according to Claim 13 or 14 wherein the algorithm uses the measured vertical displacement of the upper backup roller carriers and the individual vertical displacement of the lower backup carriers.

16. A method according to Claim 13 wherein the pivotal position of the upper backup carrier is adjusted by means of sliding a wedge bar.

17. A method according to any of Claims 13 to 16 wherein the algorithm includes equations that describe a statically indeterminate beam when subjected to a uniformly distributed

load whilst being supported in a manner as prescribed by the configuration of the intermediate and backup rollers.

18. A method according to any of Claims 13 to 17 wherein a load cell is used to measure the reaction load at the load points.

19. A method according to any of Claims 13 to 18 wherein forces are applied to the roller carriers by hydraulic means.

20. A method of levelling material using a levelling machine comprising upper work rolls and lower work rolls said lower work rolls being supported by a plurality of lower backup rollers, means of measuring the reaction load at support point for each backup roller and a Load Control Algorithm for controlling the process comprising the following steps:

calculating the expected distribution of load at said support points assuming the lower work rolls to be slender beams carrying a uniformly distributed load over the contact area of the material and supported by the lower backup rollers;

calculating the differences between said expected load distribution and a measured load distribution (XLO);

adjusting machine parameters until said calculated difference (XLO) is near to or equal to zero.

21. A method according to Claim 20 wherein the machine parameters include one or more of: work roll position measurements.

22. A method according to Claims 20 or 21 wherein the Load Control Algorithm uses one or more of: material parameters; width, thickness, yield stress, modulus of elasticity in order to set XLO near to or equal to zero.

23. A method according to any of Claims 20 to 22 wherein each backup roller pivots about an axis and the support point is located at a point proximal the pivot axis of the last (exit) work roll.

24. A method according to any of Claims 20 to 23 wherein upward movement of the upper rolls is constrained by a plurality of upper backup rollers with means of measuring the reaction load at a holding point for each upper backup roller wherein the Load Control Algorithm; calculates the expected distribution of load at said holding points assuming the upper work rolls to be slender beams carrying a uniformly distributed load over the contact area of the material and constrained by the upper backup rollers; then calculates the differences (ELOs) between said expected load distribution and a measured load distribution at the holding points, and uses said (ELO) values to set (XLO) near to or equal to zero.

25. A levelling machine according to any of Claims 1 to 12 wherein the exit (last) backup roller is approximately twice the width of the entry (first) backup roller.

26. A levelling machine according to any of Claims 1 to 12 and 25 comprising an upper exit work roll and a lower exit work roll wherein the rotational axes of the upper exit work roll and the lower exit work roll are parallel.

27. A levelling machine comprising upper and lower work rolls supported by upper and lower backup carriers, means for measuring the reaction load at load points on the lower backup carriers; means of adjusting upward forces applied proximal the free end of each lower backup roller carrier so that calculated reaction loads are induced at load points located on the pivot axis of each lower backup roller carrier; wherein said calculated reaction loads are calculated by an algorithm based upon there being a uniformly distributed stress in the material being processed as it exits the work rolls.

28. A method of removing part or all of a cassette from a levelling machine comprising the following steps:

(a) Supporting the cassette or part therof on a support member that forms an integral part of the levelling machine said support member being in a first position within the main frame of the machine and being translocatable from said first position to a second position external of the main frame of the machine;

(b) Pushing the support member carrying the cassette or part therof to the second position.

29 A method according to Claim 28 including the step:

(c) raising the support member under the cassette or part therof while in the first position to provide said support of the cassette.

30 A method according to Claim 29 wherein the support member is raised by one or more jacks.

31 A method according to any of Claim 28 to 30 wherein the support member is translocated by sliding on wheels or bearings.

32 A method according to any of Claims 28 to 31 wherein hydraulic means are used to push the support member to said second position.

33 Levelling machine cassette removal apparatus, for removing at least part of a roller cassette from the main frame of a levelling machine comprising a support member that forms an integral part of the levelling machine wherein the support member is mounted translocatable from a first position within the main frame and located under and supporting part of all of the cassette of the machine to a second position external of the

main frame of the machine, thus facilitating removal of part or all of the cassette from the machine.

34 A levelling machine according to Claim 33 wherein the support member moves on wheels or bearings during translocation.

35 A levelling machine according to Claim 33 or 34 wherein one or more jacks allow the support member to be raised while in the first position so that the cassette or part therof is supported on the support member.

36 A levelling machine according to Claim 33 or 35 wherein hydraulic means is provided to push the support member from the said first position to said second position.

Levelling Machine and Method

A levelling machine for working the coiling tendencies out of sheet metal and the like, comprising an upper set of work rolls with sets of backup rollers rotationally mounted within upper backup carriers pivotable about a first axis and a lower set of work rolls with sets of backup rollers each in a lower backup carrier pivotable about a second axis, where the first and second axes are substantially parallel and fixed relative to each other in use. A method for controlling such a levelling machine and an apparatus and method for removing casettes from the main frame of a levelling machine.

(Figure 1)